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THE ORGANIZATION OF BIOLOGY AND AGRICULTURE

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OVER and over again as I endeavor to facilitate the contributions of biology and agriculture toward winning the war, I encounter the unorganized and incoherent condition of our group of sciences. I have come to believe that this lack of organization, and the lack of unified objectives that goes with it, is of itself partly responsible for the comparatively ineffective application of biology and agriculture to the needs of a total war.

To assist in clarifying our functions and our responsibilities, I have constructed an organization chart (Fig. 1). In its conception the chart is entirely abstract. Its contact with the present situation comes through the numbered references in the appropriate boxes to the national technical societies in whose hands to a large extent lies the professional guidance of those arts and sciences by which man produces his food and the organic raw materials which he uses in his civilization.

To point out that the products of the soil constitute the most fundamental and the only really essential factors in man's existence is to state a truism to which there is no occasion to call your attention. The chart is presented, rather, to emphasize the complexity of the problem of organization which is faced by biology, using that term in its widest sense including its applications.

The outstanding feature of biology and agriculture, and it must immediately occur upon any consideration of these fields, is the number and diversity of the organizations included in the group. Whereas chemists of all sorts support one strong chemical society,

biologists have set up a number of weak societies. The problem of organizing biology and agriculture is altogether too similar to that of consummating the consolidation of the several weak Protestant churches frequently found in a rural community.

In its bulletin on "Industrial Research," p. 250, the National Resources Planning Board gives an organization chart for physics in America. It is neatly set forth in seven boxes, which include the national societies and culminates in the American Institute of Phys-

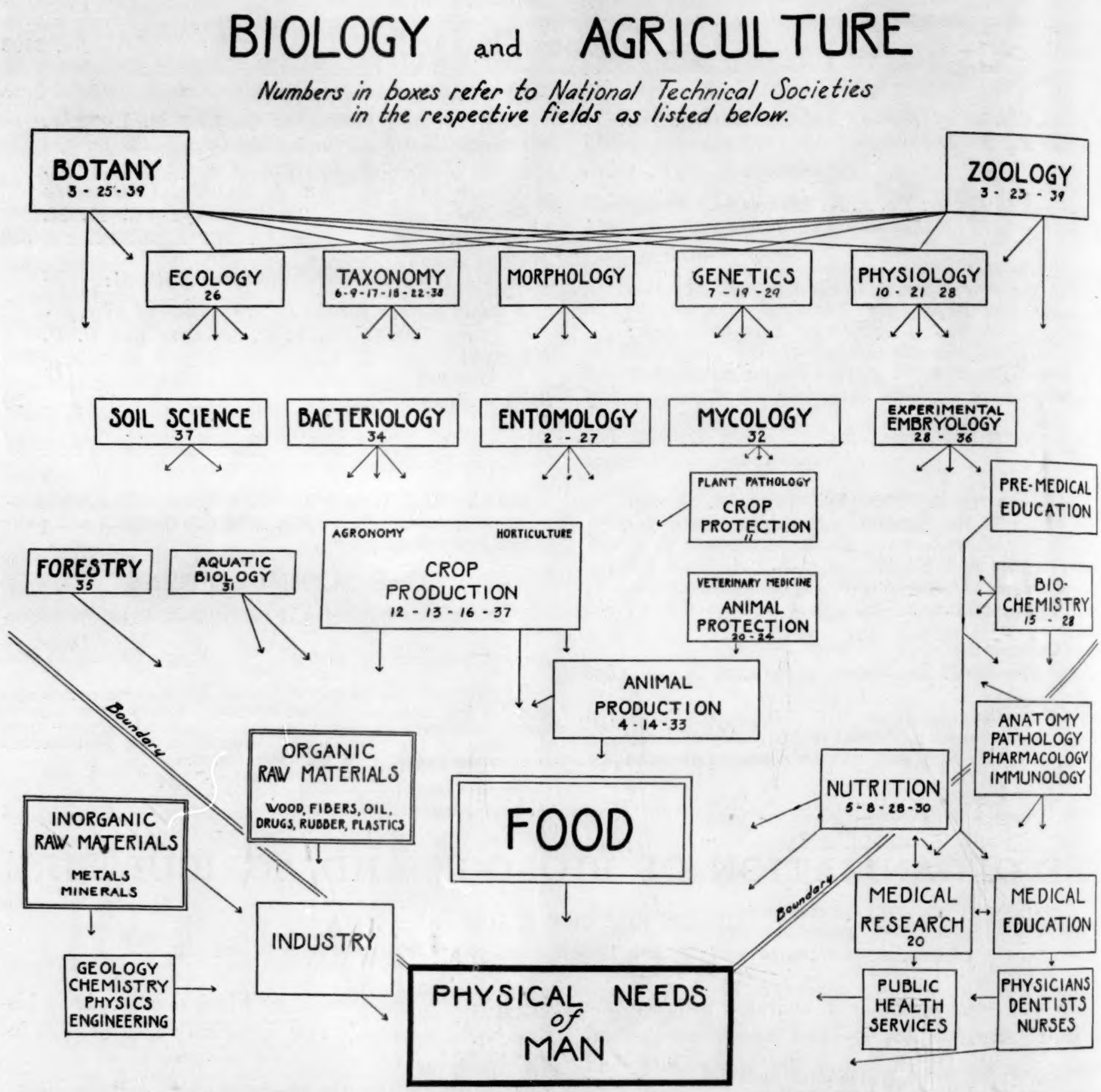

FIG. 1. Organization Chart.

National Technical Societies: 1. American Association of Anatomists. 2. American Association of Economic Entomologists. 3. American Biological Society. 4. American Dairy Science Association. 5. American Dietetic Association. 6. American Fern Society, Inc. 7. American Genetic Association. 8. American Institute of Nutrition. 9. American Ornithologists' Union. 10. American Physiological Society. 11. American Phytopathological Society. 12. American Society of Agricultural Sciences. 13. American Society of Agronomy. 14. American Society of Animal Production. 15. American Society of Biological Chemists, Inc. 16. American Society for Horticultural Science. 17. American Society of Ichthyologists and Herpetologists. 18. American Society of Mammalogists. 19. American Society of Naturalists. 20. American Society of Parasitologists. 21. American Society of Plant Physiologists. 22. American Society of Plant Taxonomists. 23. American Society of Zoologists. 24. American Veterinary Medical Association. 25. Botanical Society of America, Inc. 26. Ecological Society of America. 27. Entomological Society of America. 28. Federation of American Societies for Experimental Biology. 29. Genetics Society of America. 30. Institute of Food Technologists. 31. Limnological Society of America. 32. Mycological Society of America. 33. Poultry Science Association. 34. Society of American Bacteriologists. 35. Society of American Foresters. 36. Society for Experimental Biology and Medicine. 37. Soil Science Society of America. 38. Sullivant Moss Society. 39. Union of American Biological Societies.

ics. Probably physics is oversimplified by this chart. But could anybody reduce biology and agriculture and their societies to similar simplicity? The representation of our field in the 31 boxes used in the chart has, in fact, required considerable compression and generalization and the omission of many important relations.

A proper organization chart which shows by straight line connections dependence and responsibility is impossible for our group. One could so connect entomology and crop protection, for instance, but medicine and animal protection also are similarly dependent on entomology, and if the application of each of our sciences were thus shown our chart would become an unintelligible mass of crisscross lines. Several of our sciences have such varied responsibilities that the connections of each would make a spiderweb reaching into almost every box on the chart. On the other hand, most of the applied fields draw from a wide variety of underlying sciences. Forestry, for instance, depends on all but one of the sciences placed higher on the chart. In view of this complexity it was impracticable to show connecting lines but, instead, some of the interrelations were indicated by arrows. For example, an arrow from forestry toward raw materials suggests the chief function of forestry, but there was no opportunity even for suggesting other important functions of forestry such as controlling erosion, harboring wild life and providing recreation areas.

The fact is that any adequate representation of our group would require for almost every member a separate organization chart, only less complex than that presented for the whole. But separate charts would necessarily leave off the interconnections between the different fields and our problem lies exactly there, for these interconnections are fully as important as the special responsibilities of each science.

The writers of the bulletin on "Industrial Research" made some rather sharp criticisms of our field, pointing out that biology has not won anything like the acceptance in industry that has come to the physical sciences. They recommended that we establish an "American Institute of Biology" comparable to the Institute of Physics. If this were construed to mean that biology has not rendered as great practical services as have the physical sciences, it would be quite incorrect. The great public institutions, state and federal, devoted to scientific agriculture through the applications of biology have no counterpart in the physical sciences. The "colleges of agriculture and mechanic arts" contemplated by the Morrill Act have, in fact, gone much further in agriculture than in engineering. One reason why industrial concerns have few biologists on their staffs is that, whereas they know they must pay for consultants in engineering, they expect to get expert advice in agriculture for nothing from government employees.

Whether a system of private-paid or of public-free consultants is better public policy is a large question into which there is no occasion to enter here. But regardless of the merits of this question, there can be no doubt but that the man who collects fees of a hundred dollars a day holds himself in higher esteem and is more highly regarded by his neighbors than the man who renders the same service gratis. Biologists would strengthen both their own self-esteem and the standing of their professions if they curtailed the consultation services they render without compensation. In the case of men attached to public institutions, it would increase the prestige of both man and institution if fees were charged for their consultations. The fees might well go into the institutional treasury if the institution gave proper recognition to the value of its men by way of salary adjustments. The biologists who are called into consultation find upon rubbing shoulders with engineers employed in the same way that, both in ability and in the value of the services they can render, they measure up to the engineers.

Two other important differences between physics and biology are manifest. First, despite the complexity of modern physics and the disappearance of the old frontiers which used to separate it from chemistry, the physicists have developed a strong guild consciousness which brings to them a sense of solidarity not possessed by biology.

The chief influence which pushes us apart is the necessity for diversified specialization. It is clear that there can be little common understanding of details among our different fields, *e.g.*, forestry and veterinary medicine; and it is equally clear that there is no possibility of important progress in any scientific field except by concentration on comparatively limited objectives. Is, then, our case hopeless? I think not. The same degree of specialization is necessary in physics or in chemistry, where its disruptive tendency is greater by reason of the vastly larger number of entities with which chemistry must deal. But physics and chemistry both retain an esprit de corps and a guild consciousness which hold them together. The source of this unity lies, I believe, in common points of view.

Is there, latent, enough of a common point of view among all the groups associated under biology to bind them together with a degree of unity far beyond that now realized? I would not presume to answer this question in its entirety, but I think any biologist, figuratively looking out of the box in which he is placed in the chart, will recognize at least that he has much more in common with the people in neighboring boxes than is given expression to in our organization.

Second, the organization of physics does not include the applications of the science in engineering. In view of the manifest advantages to both physics and to engineering of their separate organizations which permit each to make its own distinctive contribution, it might be concluded that biology and agriculture should forthwith be similarly separated. Such separation looks right logically and will probably be desirable—ultimately. But in my opinion separation of agriculture from biology at the present time would be unwise. Biology is contributing so much to the development of agriculture and agriculture is stimulating the advance of biology so greatly that both would lose by separation at this juncture. Indeed I believe it can be demonstrated that a closer integration would increase the progress of both for some time to come. If this be correct, we should use every means to bring the two closer together.

The need for integration between biology and agriculture is increased by the war, for war at once puts greater emphasis on the practical and makes greater demands for innovations and these must be based on the principles of pure science.

Belief that a strong organization of the biological sciences would be advantageous is in no way novel or original to the writer. Some years since, the Union of American Biological Societies was organized and more recently the American Biological Society was launched. Both have been primarily concerned with promoting *Biological Abstracts,* a highly desirable project in itself but no adequate objective for such far-reaching organizations. Their initiation was indeed something like putting the cart before the horse. A strong federation of biologists would certainly feel the need of an abstracting journal and would support one. But such a journal can not create a federation.

I believe that all branches of biology (in the broadest sense) realize to some extent the advantages that would accrue from a strong federation of biological interests and, I think, all elements if properly treated will go along with steps to develop the bonds supplied by our many common interests. But such a living organization could not be produced by fiat. The present paper is submitted as an analysis of our actual situation. It does not include a program of action. It is my feeling that any changes in the relationships of our constituent groups will have to grow slowly and that to a large extent they will have to be initiated by the groups themselves.

Is it worth the great effort which will be required to federate the biological sciences? What may be expected from the life sciences in the years to come? During the past century the physical sciences have transformed our environment by producing all sorts of mechanical conveniences which have freed mankind from the long hours of toil before required to produce the bare necessities of existence. Among the life sciences this last century has been a time of preparation. We have learned how to protect man from many of the diseases which heretofore carried him off before his time. We have learned much of heredity and of the principles which underlie the production of improved domestic animals and crop plants. We are learning through the application of the new science of nutrition that man properly nourished maintains a vigor in life never before thought possible.

Such things have been slowly emerging through the period that is closing. The years ahead will see applications of biology to the betterment of human conditions such as we can now hardly imagine. This development will require all the detailed specialized technical tools that we possess—but more, it will require broad insight and applications of biological principles to world problems by men of affairs. Will the professional biologists play their rightful roles in this future, or will they barter their heritage for a mess of specialities?

Specialists often fail to recognize the bearing of advances in cognate fields on their work. If there were some way of bringing home to them their own need of relating their work to fields other than their own, the problem of the organization of biology and agriculture would be well on the way to solution, for there would be a spontaneous desire to bring together information and ideas from fields at present sharply separated. One trouble is that it is so much easier to follow developments in one narrow line than to keep abreast of advances along a wide front, and men will follow the line of least resistance. But lines of specialization are soon worked out and the men who survive have to shift into other lines. To adjust himself successfully to changing conditions, a man needs the broad outlook which can be most readily maintained by diversified contact with several fields.

Several correspondents have given the opinion that biologists are suffering from an inferiority complex and that this is one of the causes of our difficulties. It was partly with this idea that I suggested above the advisability of more paid consultative work by biologists and agriculturalists. Certainly it is advantageous for men in academic circles to have contacts with men of affairs. College and university men are too used to being taken care of by their institutions. We need to learn better to take care of ourselves, and in so far as we do so we will command a larger place in the scheme of things.

There are two main and fairly distinct, though considerably intertwined, avenues by which biologists serve society. These are in addition to the less direct

general educational services that come from the cultural values of instruction in biology, which our fields share with other sciences, arts and letters.

The first and oldest of these two services is as preparation and background for the medical sciences. In the old days before the development of scientific medicine all of biology contributed thus to medicine. In the beginning the physician had largely to gather his own drug plants and so the early botanists were physicians who had specialized into a knowledge of plants. This was true of most of the old herbalists, of Linnaeus and of Asa Gray.

But the rise of pharmacology, which proved that comparatively few of the old herbs possess important therapeutic value, and the achievements of synthetic chemistry which produce more and more drugs in the laboratory took away the practical value of the old herb doctor's botanical lore. Thus botany came to play a minor part in medicine.

By this development botany was deprived for the time being of its chief professional outlet. At the same time the rise of comparative anatomy, embryology, physiology, and especially of experimental zoology, accompanied by the researches in medicine itself which led to the establishment of scientific medicine, greatly increased the importance of zoology to medicine and gave a greatly enlarged outlet to students of zoology. The improvements brought about in the treatment of disease likewise vastly expanded the opportunities for service in medicine and increased correspondingly the number of physicians. The training of recruits to the army of physicians, which now numbers above 150,000 in this country alone, is in itself a very large undertaking—large enough to absorb the energies of a considerable body of men.

Thus it has happened that, without looking beyond medicine with its preparatory and cognate subjects, the zoologists have found abundant profitable and useful scope. This is not to charge that zoologists have limited their activities in any narrow way to medical interests. The reverse is quite generally the case. Very often the zoologist whose students go largely into medicine undertakes researches as far removed from medical application as possible. But the fact that medicine is the destination of the majority of students who take zoology has given that science a bent which produces the largest element of disunity in our organization as may be seen by observing how the zoological and medical aspects of biology stand apart from the agricultural in our chart.

While zoology[1] has benefited very greatly by thus having an outlet for service through medicine, it has also suffered the loss through that outlet of many of its best men. Every teacher of zoology knows that many of the students best fitted to become zoologists go into medicine. If the pull of the medical sciences were not quite so strong, zoology itself might be stronger. If opportunities for placement of zoologists in premedical fields had been less, zoology might have entered more completely into the whole of its domain. As it is, it has left large segments of the animal sciences to be developed by other hands.

Both zoology and agriculture have lost by this separation. There are, for instance, among the zoologists many able geneticists. Their achievements in discovering and formulating the laws of inheritance have been outstanding. Among them is the only American biologist who has been awarded a Nobel prize. Few of these men, however, are in touch with the Society for Animal Production. Out of roughly a thousand members of the American Society of Zoologists only eleven are also members of the Society for Animal Production. Perhaps it is a direct consequence of the separation of these interests that during the four decades in which the Mendelian Theory has been available, animal breeding has brought forth no achievements comparable in economic returns with hybrid corn or even with the large number of polyploid flowers and fruits recently produced by plant breeders.

By all the logic of the natural relations of subject matter zoology should be as much interested in parasitology, entomology, veterinary medicine, animal production, animal breeding and animal ecology as in medicine. But as a matter of fact, zoologists have been so much occupied with premedical interests that the agricultural animal sciences have been largely left to Experiment Station workers, and there has been little community of interest between the two groups.

It is not intended to suggest that the same individual could attain proficiency in more than one branch of science. The significant thing is that the organizations of the two groups of animal sciences have drifted apart. Perhaps the most striking illustration of this divergence is that between zoology and entomology. Entomology grew up in the service of agriculture even more than zoology and medicine have grown together. While the American Association of Economic Entomologists was founded in 1889, it was not thought necessary until 1906 to foster the development of the science itself, as distinguished from its applications, by establishing the Entomological Society of America. Although insects are as much a

[1] Perhaps I am using zoology in too narrow a sense here. For present purposes I am drawing my definition of the science itself from the objectives and attitudes of the American Society of Zoologists, which I recognize is not an entirely fair procedure. Yet, that ought to be the proper way to find out the nature of zoology.

part of the domain of zoology as are marine invertebrates, the members of the American Society of Zoologists have concerned themselves very much more with the latter than with the former. Students of marine invertebrates are sufficiently at home in that society that they have not set up a specialized society of their own comparable with the entomological societies.

But while students of other groups of invertebrates are generally members of the American Society of Zoologists, the entomologists generally are not so affiliated. Less than one per cent. of the Association of Economic Entomologists and only six per cent of the members of the Entomological Society of America are members or associates of the American Society of Zoologists.

In the early days of their development both botany and zoology prided themselves on being "pure" sciences and disdained applications to industry and agriculture. Finding adequate outlets in the development of the medical sciences, zoology has maintained this position, though with little of the "holier than thou" attitude with which both botanists and zoologists regarded applied scientists forty years ago. To this day, however, comparatively few members of the American Society of Zoologists are professionally engaged in applied science. So far as medicine is concerned, the separation of the pure sciences underlying the applied medical arts has been enforced by strong professional esprit de corps among physicians as well as among zoologists.

Botany, however, was compelled to take a different course. Deprived of its original usefulness by the decline of the herb doctor, botany found itself without adequate outlet for the energy of its devotees or their students. It was forced to make itself useful to agriculture. With the passing of time that connection has broadened and strengthened to the mutual advantage of both participants.

It is instructive to remember that in the beginning botanists were as much traditionally opposed to economic work as any other scientists. One of the ablest of mycologists, for example, who was forced in his youth to accept a position in an Experiment Station and there made an outstanding contribution toward the control of potato scab, always as long as he lived professed to be ashamed of this work and devoted the balance of his life to the study of fungi with no possible economic importance. But this man stood alone for many years before his death and a large majority of his students took up economic work. Again the extent to which the integration of botany and plant pathology has gone may be judged by the fact that of the total membership of the Phytopathological Society, approximately 20 per cent. maintain membership in the Botanical Society of America.

The most significant advances among the plant sciences during the last decade have occurred in plant physiology. Here more than anywhere else the interdependence of pure and applied science has been manifest. As long as plant physiology remained a pure science confined to old line university departments of botany, it never amounted to much. Indeed beans and corn were about all the materials used and the work did not get beyond the demonstration of a few simple principles—just enough to show that the subject had potentialities.

But when agriculture began to ask questions about the scientific basis of plant production and coupled these questions with appropriations for their answer, plant physiology began to advance. This at once brought into high relief our lack of understanding of the fundamentals of that field. As a result the science itself has evolved, up to now, rather more than its applications. But within the last few years these advances in fundamentals have permitted applications of rapidly increasing importance, starting a development which bids fair to become one of the most important in all biology.

Because of its importance to medicine, bacteriology is closer to zoology than is any other of the plant sciences. There are, indeed, about as many teaching positions requiring a combination of bacteriology with zoology as with botany. But bacteriology in its own right is no more a medical subject than is chemistry. Like chemistry, its applications reach into almost every field of biology and agriculture. It was impossible, therefore, adequately to represent its relations on our organization chart. Unlike chemistry, however, bacteriology has permitted the importance of its applications to dwarf the growth of the science itself. A parallel situation would be presented if chemical engineering had attempted to advance without physical chemistry. It seems likely that if the bacteriologists could set aside some of their best men to develop the pure science of bacteriology for its own sake, the fundamental principles so brought to light would lead to greater applications even than those which have been made already.

Physiology is in many schools merely *human* physiology. There is very slight contact between the physiological departments of medical schools and *plant* physiology. Yet in its fundamentals physiology has as broad an applicability as any of the biological sciences. Many have emphasized the importance of *general* physiology and most agree that it ought to be widely taught, especially for the broadening of men preparing for medicine, but it has never flourished. The reason lies probably in the bias of the premedical students who flood our biology departments. They are continually pressing for courses more and more nearly similar to the medical work to which they look

forward. Most medical schools as well as most departments of biology deplore this tendency and would be glad to compel premedical students to broaden the biological base on which to build their medical work. But they have not been strong enough to force the students into the preparation which would be best for them, and in this situation general physiology has languished.

Biochemistry, perhaps even more than physiology, is properly a field of general biology. But many departments of biochemistry instead of representing the fundamental science are mere adjuncts of medical schools. At the other extreme "Agricultural Chemistry" developed independently, starting from very narrow applications of chemistry to fertilizer analysis and such practical matters. Happily the progress of the science has brought about considerable rapprochement between the agricultural and the medical biochemists, but there is still far too wide a gap between them. Like physiology, biochemistry is in its nature more properly a pure science which (like physics) should be strongest in universities, rather than an applied science (like engineering) strongest in technical schools. In suggesting this I am not pleading especially for the pure sciences, for I believe it can not be gainsaid that strong departments concerned with these sciences for their own sake would extend and increase the usefulness of their applications.

The scarcity of departments of pure physiology and of pure biochemistry is sufficient evidence that the biological sciences in the universities are not strong enough to stretch out and occupy all of the fields of biology which should be cultivated. They need help here from the applied branches. Agriculture and medicine should unite in demanding that the universities establish departments of physiology, of biochemistry, and of bacteriology to prepare students for the technical schools with no more emphasis on applications than is given by university departments of physics preparing students for the engineering schools. If this were done, all biology would be greatly strengthened. The corresponding departments in the technical schools would find their own hands strengthened and would grow into an increased usefulness which would be hard to envisage at the present time.

All biological sciences spring from the same root. They are like a tree with many branches. Some of the branches, however, have grown so vigorously and reached such distances from the trunk that they have forgotten their origins and consider themselves independent trees. This analogy is due to C. V. Taylor of Stanford, a zoologist, who is distressed by the degree of separation that has developed among the different members of our group. Taylor points out that all living things are made of a protoplasm which, despite the widely diverse types into which it develops, remains on the whole surprisingly uniform in fundamental character throughout. The laws of its evolution and of its inheritance are the same everywhere. To a very large degree even its cellular structures are constant.

In so far as the analogy of the growing tree is applicable, it will be recognized that it is just those branches which grow most vigorously that get farthest away from the main trunk. Also, in the tree there is dead wood and there are rotten branches which may not be detected until stress and storm search them out. Likewise, on a tree leaves which almost touch may draw their sustenance from different branches which may have grown independently for a long time so that the only way to get from one to the other is to go clear back to the root. In the tree the original connection to trunk and to roots is essential. If it is severed at any point, every part beyond the cut dies.

The question really before the assemblage of sciences now grouped under biology and agriculture is whether we are comparable to a tree with a single trunk or whether we are more like a bush with many trunks from the same root. If we are like a bush, the health of any one branch is of little concern to the others. Indeed, when a branch is cut out of a bush the others grow all the better, profiting from the removal of competition. But if we are like a tree, then it behooves us to look after the health of the trunk that supports us all.

Is biology like a bush or is it like a tree? The question can be answered with assurance only with the passage of time. It is permissible, however, to make one observation: Bushes rarely attain any great height and they are mostly shortlived. The really tall and permanent growths are all trees.

OBITUARY

JOHN JOSEPH RONAN

Enemy torpedo action on October 14, 1942, tragically ended the career of a young Canadian scientist, John Joseph Ronan, field officer of the Geological Survey of Newfoundland. On leave from St. Francis Xavier University, Antigonish, Nova Scotia, to whose staff he had just been appointed, Mr. Ronan was proceeding to Newfoundland to resume field work on war minerals when he was numbered with 137 who lost their lives in the sinking of the Newfoundland Railway Steamship *Caribou* in Cabot Strait.

John Joseph Ronan was born at Antigonish, Nova

Scotia, on April 18, 1917, the son of Dr. and Mrs. M. F. Ronan. He received his early education at Morrison School and graduated in 1935 from St. Francis Xavier University with the degree of B.Sc., *magna cum laude,* a few weeks after his eighteenth birthday. Some of the results of his petrographical studies for the M.A. degree at the same institution were incorporated by his professor, the late Dr. Donald F. MacDonald, geological adviser on Panama Canal work, in "Contributions to Panama Geology" (*Jour. Geol.,* 45: 655–662, 1937).

In 1936 Mr. Ronan was awarded an assistantship in the Department of Geology at the Catholic University of America, Washington, D. C., which position he occupied for the next three years. In 1939 he went to the University of Wisconsin as holder of the Charles R. Van Hise Fellowship and remained at Madison until June, 1942, as research assistant.

Laying a broad and firm foundation of field experience for his professional career, Mr. Ronan spent the summers of 1936 to 1940 as field assistant with parties of the Geological Survey of Canada in Nova Scotia, Quebec and Ontario. The Department of Mines of Nova Scotia in 1941 made him a grant to study the igneous rocks of Guysborough County; this was to have been the subject of his doctorate dissertation at the University of Wisconsin.

Unselfishly interrupting his graduate research, which was nearing completion, Mr. Ronan last summer assumed charge of one of the field parties of the Geological Survey of Newfoundland to investigate iron and strontium resources, and after the regular field season consented to supervise further diamond drilling operations on these ores, which are important in the war effort. He met his death when about to take up his winter duties.

In grateful tribute, the mineral location at Boswarlos, Port au Port Bay, west coast of Newfoundland, to which John Joseph Ronan was devoting his scientific training, henceforth will be known officially as the "Ronan Strontium Deposit."

A. K. SNELGROVE

GEOLOGICAL SURVEY OF NEWFOUNDLAND

RECENT DEATHS

DR. HARRISON E. HOWE, editor of *Industrial and Engineering Chemistry,* died on December 10 at the age of sixty years.

ROBERT PEELE, professor emeritus of mining engineering of the School of Mines of Columbia University and editor since 1917 of "The Mining Engineers' Handbook," died on December 8. He was eighty-four years old.

DR. ALFRED BAKER SPALDING, since 1930 emeritus professor of gynecology and obstetrics of the School of Medicine of Stanford University, died on November 27 at the age of sixty-eight years.

DR. FREDERICK MARK BECKET, consultant to the Union Carbide and Carbon Corporation, New York, N. Y., died on December 1 at the age of sixty-seven years.

CHARLES W. FREDERICK, head of the Science Division of the lens factory of the Eastman Kodak Company at Rochester, N. Y., died on November 29 at the age of seventy-two years.

THE death at the age of eighty-four years is announced of Sir Henry Miers. Sir Henry was Waynflete professor of mineralogy at the University of Oxford from 1895 to 1908; principal of the University of London, 1908 to 1915, and vice-chancellor of the University of Manchester and professor of crystallography, 1915 to 1926.

Nature records the death of Dr. Alfred Baker, emeritus professor of mathematics of the University of Toronto, where he occupied the chair of mathematics from 1887 until 1919, president in 1915 of the Royal Society of Canada, on October 27, at the age of ninety-four years; of Dr. J. N. Collie, F.R.S., emeritus professor of organic chemistry of the University of London, on November 1, at the age of eighty-three years, and of Dr. J. C. Schoute, emeritus professor of botany of the University of Groningen, president of the sixth International Botanical Congress, at the age of sixty-five years.

THE death is announced at the age of seventy-seven years of Professor Carl Dorno, who founded and directed the Physical Meteorological Observatory at Davos, Switzerland.

SCIENTIFIC EVENTS

GRANTS FOR WAR RESEARCH TO THE UNIVERSITY OF CINCINNATI

CONTRACTS with the United States Government for war research by the University of Cincinnati negotiated during the summer, reported by Dr. Raymond Walters, president of the university, were approved on October 6 by the board of directors of the university.

Ranging from \$2,500 to \$12,000 and amounting in all to \$42,000, these contracts are for investigations now under way in the College of Medicine and the department of leather research of the university for the Office of Scientific Research and Development and in the College of Engineering and Commerce for the Army Air Corps.

In several instances the federal grants were exten-

sions of earlier contracts for the same types of research. In one case, the government allowance was for a six months period and will be renewed for the same amount at the expiration of the current contract.

Nearly $45,000 in gifts and grants were reported. Of these, six, amounting to more than $32,000, were designated to aid the nutritional research being directed in the College of Medicine, under the supervision of Dr. Tom D. Spies, associate professor of medicine. Of the nutrition grants, the largest was for $16,000 from the Williams-Waterman fund for the combat of dietary diseases through the Research Corporation, New York City, to support the work of Dr. Spies for two years. Other nutrition grants included $5,000 from the Gelatin Products Company, Detroit, Mich.; $5,000 from the Anheuser-Busch, Inc., St. Louis; $3,000 from Standard Brands, Inc., New York; $3,000 from the Continental Baking Company, New York, as partial payment of a $10,000 contribution for the year beginning on July 15, 1942; and $50 from Starling W. Childs, Cleveland. Dr. Spies's clinical studies on nutrition are carried on at the Hillman Clinic, Birmingham, Ala.

The W. K. Kellogg Foundation, Battle Creek, Mich., gave $4,000 to establish loan and scholarship funds in the School of Nursing and Health. The same foundation last spring gave $10,000 for similar funds in the College of Medicine.

THE SUPPLY OF TECHNICAL MEN TO THE ARMED FORCES AND TO INDUSTRY

To ensure a continuous flow of young engineers to the armed forces and to industry has been a serious concern to national engineering societies. The supply is already so limited that a contest was developing between the needs of the army, navy, air and signal corps, and the requirements for industrial research, design, production and maintenance.

Facts have been published which showed that a larger number of skilled engineers were required for production and maintenance than was necessary in plant layout. New designs, modernization and war production make demands on the engineering colleges that they provide a steady stream of young engineers for the armed services and industry.

In October, the Engineers' Council for Professional Development called a meeting of industrial personnel and engineering teachers who drew up a statement emphasizing the need for adequate supplies of young technical men.

In November, the American Institute of Chemical Engineers prepared a statement of "significant facts" and strongly recommended:

A. That the loss of technically trained men from war production plants be stopped by cessation of voluntary enlistment or by a "freezing" order covering such personnel and plants.

B. That selective service occupational Bulletin No. 10 of last June be reaffirmed in principle in its provisions for the deferment of men in engineering training.

C. That this directive be modified in the light of the lower draft age by providing for the deferment of engineering students in established colleges to the end of the term in which they reach the age of 18, and thereafter, on a term by term basis as long as their academic records remain satisfactory.

On December 4, the council of the American Society of Mechanical Engineers passed the following:

Whereas, technically trained engineers are indispensable to modern mechanized warfare and are needed in greater and greater numbers by the armed forces and by the war industries and will be equally essential to the rehabilitation program,

Therefore, be it resolved that the Council of the American Society of Mechanical Engineers, acting on behalf of the membership of the society, at the sixty-third annual meeting of the society held in New York, November 30th to December 4th, 1942, is convinced that the effective prosecution of the war effort demands that an adequate supply of engineers be insured for the armed forces and the war industries through the deferment of certain students in engineering colleges under the following conditions:

(1) Enrolment in a college with a curriculum professionally accredited by the Engineers' Council for Professional Development.

(2) Completion of not less than one term or one semester's work in an accredited professional curriculum in engineering with an average scholastic grade at least equal to that required for graduation.

This resolution was sent to the President, the Chairman of the War Manpower Commission and the Director of the Selective Service.

On December 8, the Consultative Committee on Engineering for the Professional and Technical Division of the War Manpower Commission adopted unanimously the following:

Recognizing the necessity for a continuing flow of professionally trained men for war industries, especially for urgent developmental work in improving the quality and production of actual weapons and materials of warfare, this Consultative Committee on Engineering for the Professional and Technical Division of the War Manpower Commission respectfully recommends that the Chairman of the War Manpower Commission immediately take the necessary steps in order to provide temporary deferment from military service for those undergraduates in recognized engineering schools who are subject to Selective Service. Such deferment is necessary pending a more thorough study of the requirements of engineering manpower both by war industries and the Armed Forces.

This recommendation confirms and re-emphasizes the resolutions made by the recent annual meetings of the American Society of Mechanical Engineers, the American Institute of Chemical Engineers, the Society for the Promotion of Engineering Education, and others, looking to the deferment of those young men who are already in

engineering training and are maintaining satisfactory academic records. This is not a recommendation for class deferment, but is a recognition of a temporary but critical phase of the manpower situation which requires prompt and decisive action to prevent serious crippling of the war program.

R. L. SACKETT

RARE CHEMICALS

THE following chemicals are wanted by the National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Dearborn and Federal Streets, Chicago, Ill.:

1. 2-chloro, 3-nitro-phenoxy acetic acid
2. 2,4-dichloro-alpha-naphthalene
3. 2,4-dichloro-beta-naphthoxyacetic acid
4. Disilicon Hexachloride
5. Quinizarin 6 sulfonic acid
6. Quinizarin boric acid
7. 2-alpha-methyl indole
8. Cyclohexene oxide
9. 2-chloro-cyclohexenone
10. d-ribose-5-phosphoric acid
11. Phospho-erythronic acid
12. Oxalacetic acid
13. Cuprous Benzene Sulfonate
14. Glucose-6-phosphoric acid
15. Phosphopyruvic acid
16. Phosphoglyceric acid
17. Dihydroxyacetone phosphate
18. Creatine phosphate
19. Acetoacetic acid
20. alpha-Ketoglutarate

THE INTER-AMERICAN PROGRAM OF THE AMERICAN STANDARDS ASSOCIATION

TRADE and industrial development of the Americas will be furthered by a program of Inter-American cooperation on industrial and engineering standards which has just been launched by the American Standards Association, according to a statement made by P. G. Agnew, secretary of the association. Such standards are helping government and industry in the United States to speed up production, conserve materials and make substantial savings.

Latin American countries have already shown interest in North American standards and have asked the American Standards Association to supply them with further information.

National standardizing bodies are now in operation in three South American countries. The one in Argentina (Instituto Argentino de Racionalización de Materiales) has been operating a number of years and publishes a monthly magazine. The one in Brazil (Associação Brasileira de Normas Técnicas) has recently issued a volume of standards. The one in Uruguay (Instituto Uruguayo de Normas Técnicas) was formed a short time ago. In other Latin American countries there are government departments and engineering societies doing similar work. Furthermore, there is a South American committee (Comité Sudamericano de Normas) to further standardization work in the ten South American republics.

Cyrus Townsend Brady, Jr., an engineer and sales executive who has spent many years in South America, will serve as the field representative for the American Standards Association. He is being given a year's leave of absence by the U. S. Steel Export Company for the purpose. His work will be supported by an Inter-American Division in the New York office of the American Standards Association, of which Alberto Magno-Rodrigues, who has been for many years in charge of the activities of several American manufacturers of machinery in the Spanish and Portuguese markets, is head.

In the new program the association will exchange technical data in the development and use of standards with the other American republics, give them information on the standardization work being done in the United States, and provide them with Spanish and Portuguese translations of standards which would be especially valuable in developing their industry. It is planned to provide interchange of technical data and information to enable all the countries of the Western Hemisphere to have standards as much alike as possible.

An advisory committee has been appointed under the chairmanship of R. E. Zimmerman, president of the association and vice-president of the U. S. Steel Corporation.

FELLOWSHIPS IN THE MEDICAL SCIENCES OF THE NATIONAL RESEARCH COUNCIL

FELLOWSHIPS in the medical sciences, similar to those which have been administered by the Medical Fellowship Board of the National Research Council since 1922, will again be available for the year beginning on July 1, 1943. These fellowships, supported by grants from the Rockefeller Foundation to the National Research Council, are designed to provide opportunities for training and experience in research in all branches of medical science. They are open to citizens of the United States or Canada who possess the degree of M.D. or Ph.D., and are intended for recent graduates who are not yet professionally established.

In addition to these fellowships the board administers two groups of research fellowships, made available through a grant from the National Foundation for Infantile Paralysis, Inc. The first group, open to applicants who hold either the Ph.D. or M.D. degree, is for the purpose of providing opportunities for special training and experience in the study of filtrable

viruses. The second group, open only to graduates in medicine who have completed one or more years of hospital experience in clinical surgery and are planning a career in orthopedic surgery, is designed to provide opportunities for training and research in those basic medical sciences which will be of particular value in furthering progress in the field of orthopedic surgery.

Fellows will be appointed at a meeting of the board late in February. Applications to receive consideration at this meeting must be filed on or before January 1. Appointments may begin on any date determined by the board.

For further particulars concerning these fellowships, application should be made to the Secretary of the Medical Fellowship Board, National Research Council, 2101 Constitution Avenue, Washington, D. C.

SCIENTIFIC NOTES AND NEWS

THE *Times,* London, reports that the King of England has approved the recommendations of the Council of the Royal Society awarding royal medals for 1942 to Professor W. N. Haworth, F.R.S., for his fundamental contributions to organic chemistry, particularly to the constitution of the sugars and the structure of complex polysaccharides, and to Dr. W. W. C. Topley, F.R.S., for his outstanding work on experimental epidemiology and immunology. Awards of medals by the president and council of the society are: the *Copley Medal* to Sir Robert Robinson, F.R.S., for research work of outstanding originality and brilliance which has influenced the whole field of organic chemistry; the *Rumford Medal* to Dr. G. M. B. Dobson, F.R.S., for his outstanding work on the physics of the upper air and its application to meteorology; the *Davy Medal* to Professor C. N. Hinshelwood, F.R.S., for his distinguished work on the mechanism of chemical reactions; the *Darwin Medal* to Professor D. M. S. Watson, F.R.S., for his researches on primitive fishes and amphibians which have much advanced the knowledge of the evolution of these groups of animals; the *Buchanan Medal* to Sir Wilson Jameson, for his distinguished administrative service to hygienic science and practice; the *Hughes Medal* to Professor Enrico Fermi, for his outstanding contributions to the knowledge of the electrical structure of matter, his work in quantum theory and his experimental studies of the neutron.

JOSIAH K. LILLY, chairman of the board of Eli Lilly and Company, was presented with the Remington Honor Medal for 1942 "for his many accomplishments in the interests of pharmacy" at a dinner given on December 2 by the local branch of the American Pharmaceutical Association in New York City.

DR. HARRY N. HOLMES, professor of chemistry and head of the department at Oberlin College, president of the American Chemical Society, has been elected an honorary member of the Chemical, Metallurgical and Mining Society of South Africa.

IT is reported in *Nature* that the Emil von Behring Prize, which is awarded by the University of Marburg every two years for outstanding achievements in immunology, serum therapy and chemotherapy, has been presented to Professor Paul Uhlenhuth, professor of hygiene and bacteriology at the University of Freiburg-im-Breisgau.

AT the seventh annual meeting of the Florida Academy of Science held at the University of Florida, Gainesville, on November 20 and 21, the following officers were elected for 1943: *President,* Robert B. Campbell, Tampa; *Vice-president,* T. H. Hubbell, University of Florida; *Secretary-Treasurer,* R. F. Bellamy, Florida State College for Women.

DR. JOHN BOSWELL WHITEHEAD, director of the School of Engineering of the Johns Hopkins University, has become professor emeritus.

DR. WILLIAM M. SMALLWOOD, head of the department of zoology at Syracuse University, will have leave of absence during the second semester prior to his official retirement in June. He has been a member of the faculty for forty-six years.

DR. RHEINART PARKER COWLES, professor of zoology at the Johns Hopkins University and for the past twelve years investigator in charge of the biological and hydrographical survey of the Chesapeake Bay, retired in September.

DR. LEE BONAR has been appointed chairman of the department of botany of the University of California at Berkeley. He succeeds Alva R. Davis, who is now a major in the Coast Artillery at Camp Callan, San Diego. Dr. Bonar has been associated with the university for the past twenty years.

THE chair of oil engineering and refining in the University of Birmingham, vacant by the death of Professor A. W. Nash, has been filled by the appointment of Dr. F. H. Garner, a graduate of the university. Dr. Garner was for many years chief chemist of the Anglo-American Oil Company.

DR. HAROLD P. BROWN, chairman of the department of chemistry of the University of Kansas City, has joined the staff of the Synthetic Rubber Division

of the Research Laboratories of the B. F. Goodrich Rubber Company, Akron, Ohio.

DR. CHARLES A. COOK, formerly senior biochemist at the Experimental Research Laboratories of Burroughs Wellcome and Company (U.S.A.), Inc., is now in charge of the department of medical and biological chemistry at the Research Laboratories of the Lambert Pharmacal Company in St. Louis.

Chemical and Engineering News states that Wilmer T. Rinehart, who was recently associated with the United States Gypsum Co. and formerly with the Roessler and Hasslacher Chemical Co. at Niagara Falls, N. Y., has joined the chemical engineering staff of the Armour Research Foundation.

THE three hundred and fifteenth meeting of the Washington Academy of Sciences was held jointly with the Anthropological Society of Washington on December 17. Matthew W. Stirling, chief of the Bureau of American Ethnology of the Smithsonian Institution, delivered an address entitled "Anthropological Explorations in Netherlands New Guinea."

DR. HARLAN TRUE STETSON, of the Massachusetts Institute of Technology, addressed the Worcester Polytechnic Institute Chapter of the Society of Sigma Xi on the occasion of the initiation of new members on December 4. He spoke on "Solar Radiation and the Upper Atmosphere."

PETER E. KRAGHT, senior meteorologist of the American Airlines, Inc., gave on December 1 a public lecture on "Meteorology and Our Daily Work" before the Kappa Chapter of Sigma Xi of Columbia University.

DR. ERNEST SACHS, professor of neurological surgery at Washington University Medical School, St. Louis, delivered the William Haggard Memorial lecture at Vanderbilt University on November 27. The subject was "The Essential Qualifications of a Great Surgeon."

JOHN LOVELL LOUGHBOROUGH, a member of the Industrial Relations Research Department of Lockheed and Vega Aircraft Corporations, has been appointed consulting anthropologist to the Advisory Council of the California State Bureau of Industrial Health. The council will advise on problems dealing with war and post-war industrial health problems.

THE American Mathematical Society and the Mathematical Association of America have voted to cancel the New York meeting, in line with the postponement of the annual meeting of the American Association for the Advancement of Science. The meetings were to have been held during Christmas week in conjunction with the association.

THE meeting and symposium which had been arranged by the American Association of Physical Anthropologists to be held jointly with Section H of the American Association for the Advancement of Science have been cancelled.

THE annual meeting of the Society of American Bacteriologists has been cancelled. It was planned to be held in Columbus, Ohio, on December 28, 29 and 30.

BY vote of the executive committee of the American Association of Anatomists, the meeting scheduled for Montreal in April, 1943, has been postponed.

THE American Statistical Association has cancelled its annual meeting, which it was planned to hold in Cleveland from December 29 to 31, because of the greatly increased need for curtailment of civilian travel resulting from the acceleration of war activities and the probability that government employees planning to participate in the program would not be granted leave for this purpose. The other societies composing the group of Allied Social Science Associations have also cancelled their Cleveland meetings. Arrangements are now being made for the presentation of a number of the papers scheduled for the annual meeting at special meetings of the Washington and New York Chapters of the association.

IT is reported in the daily press that a national committee to aid the war effort, none of whose members will go to Washington, is being organized. Members will consult individually with War Production Board representatives by telephone and letter only, and will not be asked to meet in Washington. The referee board of the chemicals division, through its chairman, Professor Donald B. Keyes, of the University of Illinois, stated that the group will be made up of leaders in research and development in the chemical and allied industries. They will serve as liaison men between their companies or industries and the referee board.

WHEN Dr. J. Shelton Horsley was president of the Virgnia Academy of Science in 1926, he raised an endowment fund amounting to $12,000, interest from which has been used since to aid and encourage younger men and women in Virginia with aptitudes for scientific investigative work. This year's research committee of the academy consists of Dr. Harvey B. Haag, *chairman,* Dr. Allen T. Gwathmey, J. H. Johnson, Dr. Gillie A. Larew, Dr. Ivey F. Lewis, Dr. Rolland J. Main and Dr. Frank C. Vilbrandt. Dr. E. C. L. Miller, secretary, and Dr. Sidney S. Negus are ex-officio members. At a recent meeting of this committee research grants were awarded to the following: Dr. Lynn D. F. Abbott, Medical College of Virginia; Professor J. A. Addlestone and Herman Hackerman,

Virginia Polytechnic Institute; W. L. Gooch, of the Chesapeake Corporation; James McD. Grayson, Virginia Polytechnic Institute; Dr. Ladley Husted, University of Virginia; Claiborne S. Jones, University of Virginia, and Dr. C. R. Spealman, Medical College of Virginia.

BECAUSE of the demand for women in certain kinds of engineering work, the Drexel Institute of Technology, Philadelphia, will accept in February women students in all departments of the School of Engineering. The Drexel Evening Diploma School opened new engineering classes on the evening of December 14 for women as well as men. The subjects offered are mathematics, algebra, geometry, trigonometry, analytical geometry and calculus, physics, inorganic chemistry, mechanical and engineering drawing, the foundations of English and advanced English. Students may enroll for one, two or three evenings a week.

A PRE-METEOROLOGICAL training course covering six months of intensive instruction in physics, mathematics and electrical engineering will be opened on March 1 at the University of Michigan. Four hundred privates from the Army are expected to be in attendance.

APPLICATIONS must be received by March 1 for the Mary Putnam Jacobi Fellowship for Medical Research of $1,000 of the Women's Medical Association. Blanks may be obtained from the secretary of the committee, Dr. Phebe L. Du Bois, 150 East 73rd Street, New York.

THE board of the second Sigma Delta Epsilon Fellowship has announced that applications and reference statements, both in triplicate, for the 1943–1944 award of $1,000 should be submitted to it before March 1. Women with the equivalent of a master's degree, conducting research in the mathematical, physical or biological sciences, who need financial assistance to complete their work for the doctorate, and give evidence of high ability and promise, are eligible. The appointee must devote the major part of her time to an approved research project, and not engage in other work for remuneration unless such work shall have received the written approval of the board before the awarding of the fellowship or in any later emergency. Application blanks may be secured from Dr. Eloise Gerry, care of the U. S. Forest Products Laboratory, Madison, Wisc. Announcement of the award will be made early in April.

PRINCETON UNIVERSITY has received a legacy by the will of Louise R. Pierson, of Orange, N. J., of $25,000 for the endowment of a sixth scholarship in memory of the late Dr. John Grier Hibben, the fourteenth president of the university. The fund will provide annually a scholarship "for a New Jersey man of outstanding scholarship, character and promise . . . who intends to make the practice of medicine his life profession."

THE James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, offers $5,000 in student awards and $1,750 in scholarships for the departments of the institutions in which the students are registered. There are seventy-seven student awards—a first award of $1,000, a second of $500, a third of $250, four awards of $150, eight of $100, twelve of $50 and fifty of $25. There are seven scholarships of $250 each. The school of the winner of the first award will receive four scholarships; of the second two, and of the third one. Any resident engineering undergraduate student registered in any school, college or university in the United States, giving a course in any branch of engineering or architecture, leading to a degree, or any cadet registered in the U. S. Military Academy, U. S. Naval Academy and the Coast Guard Academy is eligible to submit a paper. The awards will be made for papers describing the conversion from other methods to arc-welded construction of parts of machines, complete machines, trusses, girders or structural parts.

THE Museum of Vertebrate Zoology of the University of California at Berkeley has recently completed the identification of birds obtained in El Salvador, Central America, in the early part of 1942. The collection, numbering 1,145 items, was made by Joe T. Marshall, Jr., assisted principally by John Davis, while they were members of the University of California's expedition to El Salvador under the direction of Dr. R. A. Stirton. The material comprises 301 separate species and subspecies. Of these 217 are new to the collection and 47 genera are for the first time represented there. One of the most valuable aspects of this collection is its inclusion of 345 complete bird skeletons of 192 species. These afford material for extensive study of the phyletic relationships of groups of Neotropical birds; skeletons of many of these species are either rare or lacking in North American and European institutions.

BIRDS, small mammal specimens, pressed plants, insects, rocks and minerals, seeds, soils, American Indian handicraft objects and other natural history and ethnological material may now be drawn from Field Museum of Natural History as are books from a public library. This is a new service inaugurated by the N. W. Harris Public School Extension Department. The new materials have been made available to provide teachers with visual aids that can be used at times when instruction in a particular subject is

being given in classrooms as part of the regular curriculum. Most of the specimens are of natural history subjects local to the Chicago area. Teachers may obtain loans of this material upon written or telephoned request, to the extent that previous loans make compliance with their requests possible.

ACCORDING to *The Experiment Station Record,* an Agricultural Machinery Development Board set up early in 1942 has established a National Institute of Agricultural Engineering at Askham Bryan, near York. The nucleus of the institute is the Institute of Research in Agricultural Engineering, transferred from Oxford by the university with its director, S. J. Wright, continuing in charge. Temporary housing in the new location will be provided in buildings belonging to the Yorkshire Council for Agricultural Education, but eventually it is intended to build permanently on a near-by site. The main functions of the new institute will be to act as a general clearing house for information about agricultural machinery and its use, to carry out tests or demonstrations of new or improved implements and to undertake experimental and demonstration work on the better utilization of existing equipment.

DISCUSSION

PREDETERMINATION OF SEX[1]

IN the past the sex of the offspring from any mating has been a matter of chance. Despite the fact that thousands of techniques have been suggested no method of sex control has stood the scrutiny of unbiased investigation.

The advent of this century contributed a major advance in understanding the mechanism behind this chance distribution of the sexes. The unbalanced condition of one or more chromosome pairs in one sex furnished the mechanism whereby the distribution of sex in a population was random with a mean approximating equality for the two sexes. The extension of the gene balance concept to our knowledge of sex determination did not alter the random nature of the sex distribution, it refined our understanding of how the randomness came about. No man-controlled environmental circumstance was found to affect the ratios of the gametes or the sex after their fusion.

Sex-linked lethals gave students of inheritance the first positive means of controlling the sex of specified progeny. The control was directional in that it reduced the numbers of males. But it was positive and could be duplicated to any interested person's satisfaction. At first this genetic control changed the sex ratio from the 50: 50 distribution to $33\frac{1}{3}$ males to $66\frac{2}{3}$ females. But the introduction of one or more lethal genes in each of the sex chromosomes with prevention of crossing over soon showed that the sex control could be made practically perfect, no males to 100 per cent. adult females. This directional genetic control of the adult sex ratio had become an accomplished fact.

Gowen and Gowen[2] demonstrated another genetic control of sex. The presence of a homozygous gene pair in the third chromosome of *Drosophila melanogaster* controlled the embryological development of the sex-differentiating organs. Besides normal males and females, individuals with a mixture of male and female organs appeared in the progeny. Inheritance control of sex even to the organ arrangement was evidently a function of this gene. But the path over which the gene worked was also learned. The gene controlled the maturation division of the parent female in such a manner that diploid and fractionally diploid eggs, instead of the haploid eggs, were produced.

Gershenson[3] in *Drosophila obscura* analyzed another case in which the genotype affects the maturation division. In this case the male instead of the female is the responsible agent. Male genotypes carrying this inheritance in their sex chromosomes have nearly 100 per cent. female progeny (96 per cent. females to 4 per cent. males) without regard to the females to which they are bred. The possible mechanism through which this inheritance may work has been further clarified by Sturtevant's and Dobzhansky's[4] observation that at maturation of this genotype the sex chromosome undergoes equational division at each meiotic division, the Y degenerates and the autosomes behave normally.

These cases furnish understandable mechanisms for shifting a normal sex ratio of 1 male to 1 female to that of all females. The other end of the sex control question, the production of all male progeny, has not been possible as yet. It is the purpose of this paper to present such a case where genotypic control leads to a progeny of 100 per cent. males.

In crosses intended for homozygosis studies, Mr. Nelson observed a pair mating of *Drosophila melanogaster* which produced 136 males and no females. The male progeny of this cross were able to transmit

[1] Journal Paper No. J–1054 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 714.

[2] Marie S. Gowen and John W. Gowen, *Am. Nat.*, 56: 286–288, 1922; John W. Gowen, SCIENCE, 68: 211–212, 1928; John W. Gowen, *Am. Nat.*, 65: 193–213, 1931.

[3] S. Gershenson, *Genetics*, 13: 488–507, 1928.

[4] A. H. Sturtevant and Th. Dobzhansky, *Genetics*, 21: 473–490, 1936; A. H. Sturtevant, *Proc. Nat. Acad. Sci.*, 23: 360–362, 1937.

the male-producing characteristic to certain of their daughters without regard to the characteristics of the mates to which they were bred. In something over 500 matings, covering a period of 8 generations from the original parent, no failures in finding the expected male-producing genotype have occurred.

The daughters with the genotype for all male progeny produce all male offspring without regard to the mates with which they are bred. The males give no phenotypic expression of this inheritance. The male-producing genotype is thus without effect on the adult males which carry it. The inheritance is sex-limited in its action in that it affects only the females which have it, acting as a dominant.

This case completes the span for the genetic control of sex. Genotypes, which may be genetically controlled, have now been established for the most divergent sex ratios possible, 100 per cent. female in one progeny and 100 per cent. male in the other. Many problems of sex differentiation and distribution are, of course, left, but in the sense of establishing means for sex control through specific agencies under man's guidance, the problem of the predetermination of sex may be said to be solved.

John W. Gowen
Ronald H. Nelson

PEDIGREED PINE FOR NAVAL STORES PRODUCTION

In the fall of 1941 the U. S. Forest Service started a project concerned with the development of an extra-high-yielding strain of naval stores pine. Efforts were directed toward the selection of naturally superior individuals and the working out of methods for their propagation. The undertaking has precedent in the notable success achieved with other tree species yielding special products. It is well known, for example, that the average output of rubber latex from *Hevea* has been greatly increased as a result of careful selection, controlled breeding and the propagation of superior clones. High-yielding strains of *Cinchona*, from which quinine is obtained, were similarly developed.

The naval stores belt was thoroughly scouted for outstanding trees—trees which for no apparent reason produced exceptional yields of oleoresin. Emphasis was placed on slash pine (*Pinus caribaea* Morel.), since this species normally yields more gum than longleaf pine (*P. palustris* Mill.), the other commercially important producer of naval stores. Of the thousands of trees inspected, twelve of the most promising were selected for further study. During the summer of 1942 the yields of these trees were accurately determined by weighing the gum produced each week. In connection with each of the twelve, equally precise data were also obtained on the yields of from fifteen to fifty control trees of the same species, age, size, growth rate and general appearance growing under similar conditions on the same site. Comparisons made near the end of the season show that the majority of the trees under test produced from two to three times as much gum as the average of their respective control groups. Because of the care used in selecting and checking the test trees, it is probable that the superiority of at least some of them is due largely to hereditary factors. In the meantime, the search continues for additional outstanding individuals.

Vegetative propagation was chosen as the most promising method for speeding up the production of planting stock having the same characteristics as the superior trees selected in the present study. The advantages and possibilities of this method and its importance in the field of forest tree genetics have been discussed by Schreiner.[1] Research in vegetative propagation, directed chiefly toward the rooting of cuttings, was started in November, 1941. Cuttings from young slash pine were used exclusively in the initial exploratory experiments. It was soon found that with proper treatment, better than 90 per cent. of this material could be rooted within five weeks from the time of planting.[2] Work was then started on cuttings from older trees, large enough to work commercially, and for which gum yield records were available. This type of material proved much more difficult to root. Thousands of cuttings from mature trees, collected at 15-day intervals, were tested during the winter, spring and summer of 1942. The material was cut and handled in different ways, given a total of 175 chemical treatments, and planted in 40 different environments provided in greenhouse and nursery. Results with the winter and spring collections were discouraging; none rooted or even calloused, and all eventually died. The first successful rooting of cuttings from mature slash pine was observed on August 19 for material collected and planted on June 20.

To date, roots have been observed only on cuttings given rather complex chemical treatments. The two most promising treatments seem to be: (1) a 24-hour treatment in a solution containing 50 ppm traumatic acid,[3] 10 ppm vitamin B_1, all essential mineral elements and 5 per cent. sugar, followed by a dust treatment with commercial Hormodin No. 2 just previous to planting; and (2) a 24-hour treatment in a solution

[1] E. J. Schreiner, *Jour. For.*, 37: 1, 61–62, 1939.

[2] H. L. Mitchell, *Naval Stores Review*, 52: 7, 10–12, 1942.

[3] Traumatic acid has been tentatively identified as 1 decene – 1, 10, dicarboxylic acid (J. English, J. Bonner and A. J. Haagen-Smit, Science, 90: 2336, 329, 1939). That used in these experiments was made available through the courtesy of Merck and Company.

containing 25 ppm indolebutyric acid, 12 ppm indoleacetic acid, 12 ppm naphthaleneacetic acid, 10 ppm vitamin B_1, all essential mineral elements and 5 per cent. sugar. The most favorable environment, according to present information, is as follows: well-drained sand as the rooting medium, full sunlight in nursery, high humidity, temperatures between 75° and 90° F., and cuttings exposed to fine spray of water (from atomizing nozzles mounted above the beds), with spray on either continuously or for 5 minutes out of each 10-minute cycle for from 10 to 12 hours each day. The spray system used is an adaptation of the spray chamber technique described by Raines.[4]

All research in propagation is being pointed toward the development of effective vegetative techniques sufficiently simple for large-scale use under nursery conditions. If successful, it is possible that certified high-yielding planting stock will be produced in public nurseries and offered for sale to land owners at or below cost. When one considers the rate at which trees grow in the naval stores belt, and that normally over 100 million trees are planted annually in the Southeast, the possibilities of this undertaking become more apparent. It is reasonable to believe that the development of high-yielding stands would contribute greatly to the solution of production problems which have long troubled the $25,000,000 a year naval stores industry, which supports some 50,000 workers and their dependents. Yield increases of 200 per cent. or more seem possible of attainment. By thus increasing the average output per tree it should be possible to reduce production costs sufficiently to meet low prices and competition from synthetics, and at the same time allow good wages for labor and an adequate profit for the producer.

H. L. MITCHELL
C. S. SCHOPMEYER
K. W. DORMAN
SOUTHERN FOREST EXPERIMENT STATION

A NEED FOR MORE UNIFORM USAGE OF WORDS OF INDEFINITE MEANING

IN science it is our practice to observe, accurately measure and record and, accordingly, we are ever faced with the necessity of posing mathematical relationships. Despite the vast and rapid accumulation of recorded data which makes up the body of our respective sciences, it is nevertheless true that the greater part of our knowledge as individuals consists of a memory of casually observed phenomena which we have not yet taken the time to analyze, accurately measure or record. Thus in our general discussions we are obliged to make use of words of indefinite meanings, such as "few," "some," "very," "many," "much," "most," "frequent," "slightly" and "seldom."

During a discussion with a group of scientific friends I was interested to note that there was no agreement among them as to the relative significance of these words. If to each mind they conveyed differing impressions, these words are not as efficient as they might be as vehicles for our thoughts. It has occurred to me that as these words are such useful tools, it would be a worth-while project to attempt to increase their usefulness by more narrowly restricting their meanings and by securing a more uniform usage.

As a preliminary step I have tabulated the impression some of these words convey to me. I have expressed them in terms of approximate percentage spread of the relative frequence or intensity they indicate to me.

TABLE 1

Per cent. frequency indicated		Per cent. frequency indicated	
1 2	very few, seldom	60 70	
3 4 5	few, some, slightly	80 90 95	most
10 15 20 25	many, much, frequent	98 99	practically all
		100	all
30 40	very many		
45 50 55	about half average (in general sense)		

Obviously their meanings must indicate approximations, for they indicate frequencies we do not know. In each case also their meanings will vary with the nature of the subject of discussion, but in each case the percentage noted is in relation to a maximum applicable to the particular case. I do not expect acceptance of any of my figures, but it would be of great interest to learn how great will be the variance shown by our readers.

P. C. ACKERMAN
MERCK AND CO. INC.,
RAHWAY, N. J.

SCIENTIFIC BOOKS

FOREST TREE SEED

Forest Tree Seed. By HENRY IVES BALDWIN. The Chronica Botanica Company, Waltham, Massachusetts, and G. E. Stechert and Company, New York, N. Y. $4.75.

THE great conservation programs that our country had under way during the middle and late 1930's re-

[4] M. A. Raines, *Am. Jour. Bot.*, 27: 10, 18, 1940.

quired vast quantities of forest tree seeds. Pines, spruces, larches, redwood and Douglas fir were planted for timber; oaks, hickories, ashes, walnut and yellow poplar to stabilize eroding farmland; hackberry, Osage orange, mulberry and green ash for shelterbelts; locusts for road banks; wild cherries and plums for game food; and many ornamentals for landscaping. For all purposes, it is estimated that the United States used annually during the late 1930's some three million pounds of forest seed, costing in the neighborhood of $1,500,000. Species used or considered for use total almost 700 for the country as a whole. In addition, prior to the war our country enjoyed a relatively vigorous export trade in tree seed, and at various times in the past has imported important quantities from Europe.

In contrast to most agricultural seed, forest tree seeds are notoriously difficult to handle. Many species bear usable seed crops irregularly, and often these are destroyed by seed-eating birds and rodents that congregate in extraordinary numbers at the time seed is shed. The fruits or cones must be harvested from tall trees or diligently searched for in well-secluded squirrel caches. Extraction techniques are involved and great care must be taken not to injure the delicate seed in the process. Unless the seed is stored under optimum moisture and temperature conditions, viability is limited in many cases to a few days' or a few weeks' time. Germination after sowing is often irregular and frequently delayed for at least a full year while seed coats disintegrate and the embryos after-ripen.

The study of tree seed cuts across the fields of genetics, embryology, histology, morphology, physiology and biochemistry on the one hand, phenology, bioclimatics, ecology, pathology, parasitology and entomology on the other. An authoritative book on tree seed is therefore both a welcome addition to plant science literature and a much-needed reference book for the many men who are engaged directly or indirectly in the use of tree seed for forest, ornamental or other planting. The preparation of such a book was an ambitious undertaking. It is fortunate that the author is widely experienced in forest research and thoroughly familiar from first-hand knowledge with a large number of tree seeds and with the techniques developed in the important American and European seed laboratories.

The first seven chapters of the book present information that the seed collector and seed dealer require, but with a broad enough background to interest students as well. Here is included the general description of seed, their life histories, their physical and chemical structure and their various economic uses. Collectors will be particularly interested in the discussion of periodicity of bearing, forecasting of seed crops and the natural distribution of seed. The seed user needs to know how many desirable hereditary characteristics are related to the geographic origin of the seed. This subject, widely studied in Europe, is receiving increasing attention in the United States by both agriculturists and foresters. However, only a few American species have been tested experimentally to determine the extent to which they contain racial differences dependent on the climate and soils of their native habitats.

Baldwin has done an excellent job in covering the collection, extraction and storage of coniferous seed. The treatment of these subjects includes both a historical résumé and the latest modern technique. Such treatment is highly desirable, inasmuch as we can find in America to-day all stages of crudity and refinement in the collection, extraction and storage of tree seed. Modern techniques of extracting seed from cones have been based on thorough experience in the artificial drying of lumber. As a result, it is now possible to use high kiln temperatures, low humidities and short extracting times, thereby recovering seed of high viability and containing the proper moisture content for storage.

The entire second part of the book is devoted to seed germination and seed testing. The fascinating interrelationships between forest seed and their natural environment, especially their mode of dispersal, storage and germination under natural conditions, unfold a field of ecology, the many ramifications of which are at present only dimly surmised. Baldwin describes clearly the many causes of dormancy and touches briefly on the utility of dormancy mechanisms in protecting the seed against loss through premature germination. The influence of external factors on germination and the chemistry of germination are both adequately handled in view of current information on these subjects. The author goes into minute detail in discussing the techniques used in seed testing and purity analyses by seed laboratories in our own country and foreign laboratories operating under the international rules for seed testing. The chapter dealing with the determination of origin by laboratory means describes a number of techniques that have been proposed, but does not point out adequately the difficulties involved in their use. Techniques that have proven more successful in determining the origin of agricultural seed, such as weed seed content, the reaction of the seedlings to various lengths of day and various physiological tests, are passed over largely because these have not yet been adapted successfully to tree seed analysis.

To the uninitiated reader it may appear that Baldwin's treatment of many subjects is hurried or super-

ficial, even though the book does contain an impressive bibliography of more than 800 citations. Actually, such an accusation has little justification. A truly exhaustive search of the literature has been made, and relatively few important omissions will be uncovered even by the specialist in the field. Suggestions for improvement can, of course, be made. For instance, the text bears signs of important omissions of data and condensations of treatment that rob it of much of the richness possible to include in a larger volume. Little space is devoted to methods of collecting, cleaning and storing the seeds of hardwoods that recently have come into wide use for shelterbelt, erosion and game food planting. It is true that little has been published on hardwood seeds even though much is known. Readers particularly interested in hardwoods will find a more complete treatment in the recent nursery handbook prepared by Engstrom and Stoeckeler.[1] The discussion of periodicity of seed production could have been strengthened materially by drawing upon horticultural literature on irregular bearing of apples and other fruits. Important studies of wind dissemination by Hesselman and others merit mention. The present status and future needs in the field of tree seed research are inadequately set forth. However, throughout the several chapters suggestions for valuable research will occur to the imaginative reader. Other subjects that might have been more completely developed for the American reader include the life history of seed, provenance and the behavior of seed in their natural environment. The Swedish and German explanations on maps and diagrams shown in the text should have been translated for American readers. The book does not bring together the status of knowledge on individual species. A manual covering this subject is now under preparation by the U. S. Forest Service.

On the whole, however, the book is scholarly, readable and informative. It fills a long-felt need. Not the least of its valuable contents is the 16-page glossary of tree seed terminology that immeasurably increases its utility. It is hoped that this book will help to open the field for intensive study during the coming years.

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ALLEGHENY FOREST EXPERIMENT STATION

[1] H. E. Engstrom and J. H. Stoeckeler. 1941. Nursery Practice for Trees and Shrubs. USDA Misc. Publ. 434.

SPECIAL ARTICLES

CROSS-CIRCULATION AS A METHOD IN THE STUDY OF DRUG FIXATION AND POISONING

IN the endeavor to study the mode of the vagoparalytic action of amytal, two cross-circulation experiments were performed in which one animal received amytal and the other paraldehyde; the latter does not paralyze the vagus. Both drugs were given one hour previous to the beginning of cross-circulation. It was believed that if amytal did not prevent the formation of acetylcholine the partner under paraldehyde anesthesia might show cardiac inhibition and fall of blood pressure following the stimulation of the vagus of the amytalized animal. The results were disappointing, however, because before the beginning of cross-circulation the vagus of the amytalized animal was paralyzed and the vagus of the other animal was not, whereas during the progress of the cross-circulation the vagus of the amytalized partner became more responsive and the vagus of the other partner less and less responsive to faradic stimulation. This substantiated the original assumption of the authors[1] that fixed anesthetics do not actually remain permanently fixed in the tissues.

It was decided to study this problem further by administering 250 mg of barbital sodium per kgm of body weight to five dogs intravenously and wait for about 2 hours until the barbital action was at its maximum. Then each of these dogs was united with an etherized partner weighing almost three times as much and cross-circulation was begun.

The pairs of dogs used in these experiments were given 2,000 Roche Inhibitor Units of heparin (Roche) per kgm. Then the left carotid artery of the first dog was connected with the right external jugular vein of the second dog, and the right carotid artery of the second dog was connected with the left external jugular vein of the first dog. This operation was carried out by tying off the cephalic end of each vessel in the neck and inserting the ends of the U-connecting cannulae into each vessel caudally. Each of the small U-cannulae was filled with normal saline and all air expelled before the ends of the cannulae were tied in place. The bull-dog clamps were removed from both carotid arteries simultaneously when cross-circulation was begun.

The cross-circulation lasted for an hour, using ether whenever necessary for tranquilization, and after this period the partners were separated from each other and their wounds closed. The dogs receiving 250 mg of barbital sodium recovered[2] in an average time of

[1] Dille, Linegar and Koppanyi, *Jour. Pharmacol.*, 55: 46, 1935.

[2] Recovery-animals can stand without support. These animals were in about the same state as those receiving 50 to 70 mg of barbital sodium per kgm.

27 minutes, whereas six control dogs receiving the same dose of barbital sodium, but not cross-circulated, recovered in an average time of 29 hours.

Two dogs received 500 mg of sodium barbital per kgm of body weight and following the period of one to two hours were similarly cross-circulated to etherized partners, the pairs being of approximately equal weights. After an hour the partners were separated and both survived and were asleep for over 24 hours. Six dogs were given 500 mg of sodium barbital and they all died; the survival periods for five dogs were 127 to 235 minutes and one died in 45 minutes.

These experiments substantiate the original thesis of Koppanyi concerning the establishment of dynamic equilibrium of barbiturates in the body and show that they are not fixed in the tissues and that they may be mobilized at any time. This method of cross-circulation is proposed to study the fixation or alleged fixation of drugs, the criterions varying, of course, from drug to drug. Opiates and digitalis principles would seem to offer a particularly fruitful field for this line of study. The authors believe that few drugs if any will not be removed by cross-circulation.

The cross-circulation obviously is a method which has given excellent results in the treatment of experimental barbiturate poisoning and probably an apparatus could be constructed to provide for slow, continuous bleeding of the poisoned individuals and to replace the drawn blood at the same rate with normal plasma or compatible whole blood.

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THE ACTION OF SULFANILAMIDE COMPOUNDS ON THE LETHAL FACTOR OF BACTERIAL TOXINS

IN most gram negative bacteria the toxic factor appears to form a part of the complex O antigen,[1] and although earlier work suggested that the antigenic, and presumably the toxic portion of the endotoxin was associated with its "polypeptide" component, more recent studies[2] indicate that this component is a protein. Our studies[3] of the property which such bacterial products have of inducing hemorrhage[4] in implanted mouse tumors led to an investigation of the mode of detoxication of these antigens when introduced parenterally.

While it is generally assumed that the action of sulfanilamide compounds is one of bacteriostasis ensuing from interference with the utilization of *p*-aminobenzoic acid, our results confirm previous findings,[5,6] that sulfanilamide also markedly increases the resistance of mice to certain preformed bacterial toxins.

The toxin used in this study was prepared by growing *Salmonella typhimurium* in a medium containing citrate and dextrose as sole organic constituents. The profuse growth was killed with 2 per cent. phenol, and the suspension transferred to regenerated cellulose tubing. The contents of the tubes were simultaneously dialyzed against water and reduced to a small volume by pervaporation in a current of warm air. The phenol-free toxin was precipitated in 80 per cent. acetone, the precipitate dried with alcohol and ether, and then taken up again in water. Injected intraperitoneally into male mice weighing 20 g, 1.3 mgm of this preparation killed 50 per cent. of the animals within twenty-four hours. This amount of toxin was therefore designated as one minimum lethal dose. It was found that 2.0 MLD killed 92 per cent. of the mice, and 10.0 and 20.0 MLD killed 100 per cent.

Compounds assayed for protective effects were administered in neutral aqueous suspension by stomach tube to mice receiving simultaneously an intraperitoneal dose of toxin. In Table 1 it is seen that sulfanilamide affords almost complete protection from 2.0 MLD of the toxin, and 33 per cent. of the mice survived 10.0 MLD. Sulfathiazole and sulfapyridine were somewhat less effective. Also, if sulfanilamide is administered one hour before the toxin is injected and is followed by supplementary doses of sulfanilamide, the degree of protection against the toxin is somewhat increased.

Animals receiving toxin together with adequately protective amounts of sulfanilamide were subcutaneously given small amounts of *p*-aminobenzoic acid. As seen in the table, the effect of *p*-aminobenzoic acid in reducing the action of the sulfanilamide and thus allowing the toxin to exert its lethal effect was quite striking, and suggests that sulfanilamide and *p*-aminobenzoic acid compete for the enzymes concerned in the detoxication effect in a manner comparable to that described for bacteriostasis.

[1] A. Boivin, *Rev. d'Immun.*, 6: 86–115, 1940.

[2] W. T. J. Morgan and S. M. Partridge, *Biochem. Jour.*, 35: 1140–63, 1941.

[3] P. A. Zahl, S. H. Hutner, S. Spitz, K. Sigiura and F. S. Cooper, *Am. Jour. Hyg.*, 36: 224–42, 1942.

[4] Experiments in progress indicate a protective action by sulfa drugs against the hemorrhage inducing effects of this antigen.

[5] C. M. Carpenter, P. L. Hawley and G. M. Barbour, SCIENCE, 88: 530–1, 1938; C. M. Carpenter and G. M. Barbour, *Proc. Soc. Exp. Biol. and Med.*, 41: 255–9, 1939; C. M. Carpenter, *Proc. Soc. Exp. Biol. and Med.*, 41: 354–7, 1939.

[6] C. Levaditi and A. Vaisman, *C. R. Soc. Biol.*, 128: 463–5; C. Levaditi, A. Vaisman and L. Reinié, *Ann. Inst. Pasteur*, 61: 635–61, 1938.

TABLE 1

Toxin	Sulfanilamide	*p*-aminobenzoic acid	Per cent. survival	No. of animals
1 M.L.D.	....	.....	52	48
2 M.L.D.	....	.....	8	36
10 M.L.D.	....	.....	0	38
.....	20 mgm (oral)	.....	95	20
2 M.L.D.	20 mgm (subc.)	.....	46	13
2 M.L.D.	20 mgm (oral)	.....	94	38
10 M.L.D.	20 mgm (oral)	.....	33	30
10 M.L.D.	20 mgm one hour prior to toxin injection plus two doses of 10 mgm each at four hour intervals (oral)	.....	45	20
20 M.L.D.	20 mgm (oral)	.....	0	9
.....	20 mgm (oral)	10 mgm (subc.)	100	11
2 M.L.D.	....	10 mgm (subc.)	0	5
2 M.L.D.	20 mgm (oral)	10 mgm (subc.)	17	35
2 M.L.D.	Sulfathiazole 20 mgm (oral)	.....	50	20
10 M.L.D.	Sulfathiazole 20 mgm (oral)	.....	0	18
2 M.L.D.	Sulfapyridine 20 mgm (oral)	.....	75	16

1 M.L.D. is designated as the amount of antigenic material required to kill within 24 hours 50% of mice injected intraperitoneally with an aqueous solution of the antigen. By dry weight 1 M.L.D. equals 1.3 mgm of toxic material.

Since sulfanilamide is not in all probability a naturally occurring substance the question arises as to whether the protective effect of sulfanilamide results from increasing the general resistance of the body to the toxin, or whether sulfanilamide or one of the products into which it is converted by the body is utilized more specifically for a detoxication process. The first hypothesis is weakened by the finding of Carpenter and associates who observed that sulfanilamide protected mice against toxins produced by such gram positive organisms as *Staphylococcus aureus* and *Clostridium welchii,* both of which differ markedly in pathogenesis from the toxins of gram-negative organisms, particularly *Salmonella* studied by us and by Levaditi, and the *Neisseria* toxins studied by Carpenter and by Levaditi.

A specific detoxication mechanism for toxic proteins, aside from hydrolysis, has never to our knowledge been proposed. The experiments of Morgan[7] showing that the toxicity of typhoid antigen is not destroyed by its homologous antibody (in contrast to the neutralizing action in other toxin-antitoxin reaction mixtures, *e.g.,* diphtheria and tetanus) may suggest that some other means, presumably non-immunological, within the body is called upon to detoxify this antigen.

This action of sulfanilamide, if it is a detoxication of bacterial toxins, may represent a special instance of the enhancement of the general detoxication of proteins within the body.

[7] H. R. Morgan, *Jour. Immunol.,* 41: 161–80, 1941.

SUMMARY

Sulfanilamide compounds protect mice against multiple lethal doses of purified *Salmonella* endotoxin. This protective action of sulfanilamide is inhibited by *p*-aminobenzoic acid.

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ANTICIPATORY CARDIAC ACCELERATION DURING SLEEP

As a part of a series of studies of sleep motility[1] at the University of Virginia, recordings of the heart rate during sleep were made. The data obtained proved to be of considerable interest and served to indicate the nature of the stimuli causing sleep movements.

Johnson[2] has called attention to the fact that during sleep, when body positions are maintained for fairly long intervals, there is, among other things, an interference of circulation (stasis of the blood and body fluids in parts of the body) and an overheating of the unventilated portions of the skin. These conditions, he suggested, must become sufficiently irritating in time to lead to a change in body position. For convenience this shall be termed the congestion hypothesis.

It is a matter of common knowledge that, as Johnson mentioned, such stimuli become irritating and even painful after some minutes. Further, it has been shown that either restriction of circulation or raising of the skin temperature produces an increase in the heart rate. If these irritating stimuli were the ones causing movement, an increase in the heart rate prior to movement would be expected. According to the same reasoning, a decrease might be shown following movement, as a change in position would relieve the irritating conditions.

This reasoning led to an experiment in which the heart rate was examined in conjunction with motility. In order to rule out the possibility of experimental artifacts interfering with the normal circulation during sleep, the heart rate was determined electrically by means of a cardiotachometer. Each heart beat was recorded on a moving strip of paper along with the movements of the sleeper. A high-speed kinetograph was used to determine precisely the onset and termination of each movement. In this study only the larger movements involving a change in position of the trunk were considered. To obtain the heart rate uncomplicated by factors other than those under consideration, a given movement must be preceded and followed by several minutes of inactivity.

[1] Results of these studies are to be published.

[2] H. M. Johnson, T. J. Swan and G. E. Weigand, *Psychol. Bull.,* 27: 18, 1930.

Records for twelve complete nights' sleep of one subject were analyzed. From these records 83 movements conforming to the preceding criteria were obtained. The average heart rate for each minute of the period beginning 6 minutes before movement and terminating 5 minutes after movement is shown graphically in Fig. 1.

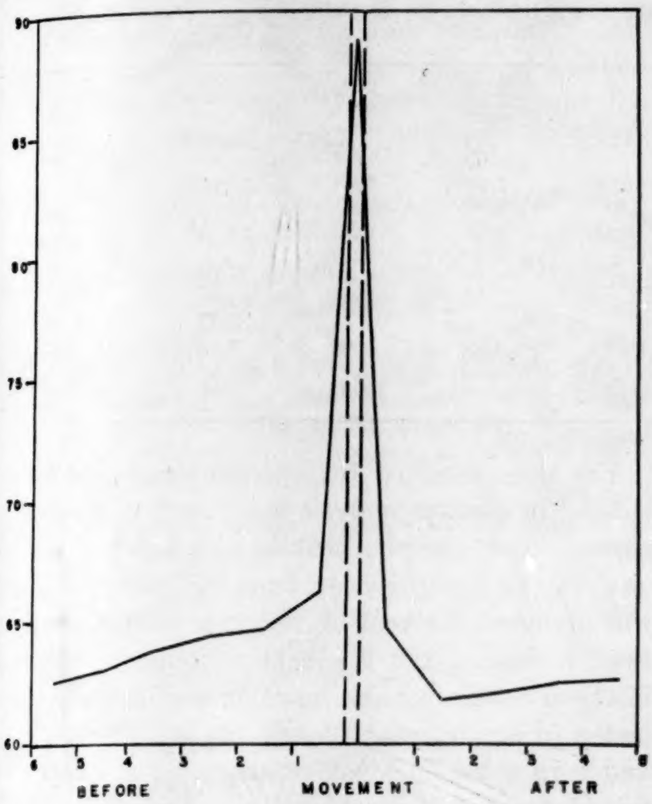

FIG. 1.

A trend of the sort suggested by the congestion hypothesis is apparent. An anticipatory increase in the heart rate is clearly demonstrated. From the curve, the rise appears to begin as much as 6 minutes before movement and the increment becomes greater until movement takes place. A minimum below that of any other period under consideration occurs soon after movement, and from this point there is a slow return to the earlier level. While of no immediate bearing on the congestion hypothesis, the much increased rate during movement is to be noted.

Analysis of the cardiotachometer records in quarter-minute intervals shows the same general trend, and the points of change are fixed more accurately in time. There is a slow rise continuing until one-half minute before movement. This is followed by a much more rapid rise that immediately precedes movement. This suggests that the anticipatory rise may be the resultant of two different functions. Statistical analysis of the data shows that both the anticipatory increase and the subsequent decrease are reliable.

These data are evidence of the correctness of the congestion hypothesis. Further experiments are planned to determine more specifically the nature of the stimulus and the mechanisms involved.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A RAPID METHOD FOR THE DETERMINATION OF NITROGEN IN PLANT TISSUE

IN view of the imminent shortage of critical elements which are necessary in maintaining crop production, it is becoming increasingly important that guess-work be eliminated in so far as possible in determining the actual fertilizer needs of economic plants. The chemical analysis of leaves as a means of determining the nature of nutritional disorders and as a tool in determining the fertilizer requirements of crop plants has received increasing attention in recent years. The investigations of Lagatu and Maume,[1] Thomas,[2] Thomas and Mack[3] and others have placed the theory of leaf analysis or "foliar diagnosis" on a sound basis. This method has not found wide application probably because of the time and expense involved in the chemical procedures usually employed. With these factors in mind, and faced with the necessity of analyzing hundreds of apple leaf samples in connection with nutrition studies, along with specimens of nutritional disorders frequently brought to the laboratory by fruit growers, we found it desirable to devise more rapid methods for the determination of some of the common nutritional elements in plant tissue.

Nitrogen is perhaps the element that is determined most often by agricultural and biological chemists, and practically all analyses are based on the standard time-consuming Kjeldahl method. A rapid acid-digestion procedure was sought which would make it possible to determine not only nitrogen, but also phosphorus, potassium, calcium, magnesium and other elements in the same sample. The use of 30 per cent. hydrogen peroxide in the presence of concentrated sulfuric acid was found to be a remarkably fast and thorough method for digesting relatively small quantities of plant material. The entire digestion takes only about five minutes, and total nitrogen, including nitrates, can be determined in the resulting solution by the standard nesslerization procedure using a photoelectric colorimeter of the test-tube type. The

[1] H. Lagatu and L. Maume, *Ann. Ecole Nat. Agr. Montpellier*, 20: 219–281, 1930.
[2] Walter Thomas, *Plant Physiol.*, 12: 571–600, 1937.
[3] Walter Thomas and Warren B. Mack, *Penn. Agr. Exp. Sta. Bull.* No. 378, 1939.

Koch-McMeekin Nessler reagent[4] was used in this work, although others would probably be just as satisfactory. Since Beer's law was not found to be valid over a wide range, a curve had to be prepared from readings based upon standard solutions of ammonium sulfate. Either fresh or dry material was found to be satisfactory for analysis, but the use of fresh material saved considerable time in sample preparation. A leaf punch which cuts out exactly one sq. cm of leaf tissue can be used, thus saving the time required to dry, grind and weigh the sample. Ten sq. cm of leaf tissue of most fruit trees is equivalent roughly to 100 mg of the dry material, and the area basis is just as satisfactory as a dry-weight basis for comparing samples.

The procedure adopted is as follows: Transfer 100 mg of dry material or 10 cm² of fresh material to a 50 ml Erlenmeyer flask. Add 2 ml of concentrated sulfuric acid and heat gently over a flame until the sample is broken down and partially dissolved. If nitrates are present, continue digestion for about a minute after dense fumes have been given off to allow for complete reduction of the nitrates by the organic matter. Allow to cool and add 0.5 ml of 30 per cent. hydrogen peroxide. Heat gently—the solution should become clear and colorless. Continue the heating until dense fumes are given off—usually the solution becomes darker at this stage. Allow to cool and add 5 drops more of 30 per cent. hydrogen peroxide and heat as before. If the solution is not completely clear and colorless on further heating, add 5 drops more of hydrogen peroxide and heat again—repeat this procedure if necessary. No more than 5 drops of hydrogen peroxide should be added at one time after the first addition, because a large excess of peroxide in the absence of organic matter will oxidize some of the ammonia. When the solution is perfectly clear and colorless on continued heating, cool, dilute with water and transfer with washings to a 100 ml volumetric flask and make to volume. Transfer a 10 ml aliquot to a 50 ml volumetric flask. Add 2 ml of 2.5 N NaOH to partially neutralize the excess acid and 1 ml of 10 per cent. sodium silicate to prevent turbidity. Make to volume and mix well. Transfer a 5 ml aliquot to a colorimeter tube and add 4 drops of Nessler's reagent—mixing thoroughly after the addition of each drop. If the mixing is not thorough, additional drops of reagent will be required to obtain the maximum color. Allow to stand for several minutes before taking a reading on the colorimeter. A blue filter (Wratten No. 49) was used in this work.

Typical comparisons between the rapid and the Kjeldahl methods and recoveries of nitrate nitrogen added to apple leaf tissues are shown in Table 1.

[4] F. C. Koch and T. L. McMeekin, *Jour. Am. Chem. Soc.*, 46: 2066–2069, 1924.

TABLE 1

REPRESENTATIVE ANALYSES OF APPLE LEAF TISSUE AND RECOVERY OF ADDED NITRATE NITROGEN. EXPRESSED AS PERCENTAGE OF DRY MATTER

Sample No.	Kjeldahl method	Rapid method	1 per cent. N added as $NaNO_3$	Recovery of added NO_3
61	2.73	2.73		
	2.73	2.71		
111	.70	.75		
	.69	.74		
216	1.77	1.81		
	1.80	1.81		
291	2.22	2.23		
	2.28	2.26		
315	1.37	1.40	2.40	101 per cent.
	1.39	1.40	2.40	101 " "
		1.37	2.41	102 " "
215	1.88	1.89	2.89	100 " "
	1.89	1.91	2.86	97 " "
		1.86	2.88	99 " "

The time required to determine nitrogen by this method in routine analysis was found to be about 10 minutes per sample, making it possible for two analysts to complete at least 48 samples a day. Furthermore, the cost of reagents is only about one twelfth that of the Kjeldahl procedure. Numerous nitrogen determinations made on replicate samples of leaves of apple, pear, peach, cherry, apricot, grape and corn gave Kjeldahl accuracy. The solution obtained from the peroxide-digested material can be used not only for the determination of nitrogen, but also for phosphorus, potassium, calcium and magnesium. Rapid colorimetric methods for the determination of these elements have been worked out and are now being prepared for publication.

Since leaf analysis offers the most promising means of diagnosing nutritional deficiencies and unbalance within the tissue of the plant, and since it eliminates most of the uncertainty in determining the actual fertilizer needs of crop plants, it is hoped that by the adoption of faster methods, leaf analysis, as a tool in increasing crop production, may come to be more widely used.

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BOOKS RECEIVED

FINK OLLIE E. *Conservation for Tomorrow's America.* Illustrated. Pp. 144. The Ohio Division of Conservation and Natural Resources. $.50.

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